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(72) Inventors ROY ALLEN and DOUGLAS KAY THOMPSON

(54) ROTARY PUMP

(71) We, ROLLS-ROYCE LIMITED, a British company of Nightingale Road, Derby, and GENERAL MOTORS CORPORATION, a company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns a rotary pump, e.g. a lubricant pump for use on a gas turbine engine.

According to the present invention there is provided a rotary pump having a housing within which two lobed elements are rotatably mounted one eccentrically within the other, the outer element having one more lobe than the inner element, said lobed elements meshing with each other so that the lobes of each element cooperate with the lobes of the other element during rotation of the elements to define spaces between the elements which successively contract and enlarge as the elements rotate through the point of mesh, and means on at least one said element providing free communication past some but not all of the lobes.

The term "sealed" as used in this specification is intended to mean that the space is completely enclosed, except that it may communicate with a port but with no other opening.

As will be appreciated the pump of the present invention may be so formed as to provide an accurately metered small flow while not requiring to be made of very small mechanical components, the small flow being achieved by reason of the fact that it may be arranged that pumping is effected by each said space during a proportion only of the said cycles.

Preferably, predetermined lobes on the lobed elements are partially cut away.

[*Price 25p*]

Preferably there are a plurality of outlet ports with which each space successively communicates while contracting in volume, whereby each said outlet port receives a proportion only of the volume of the pumped fluid. As will be appreciated, if only one of the said outlet ports communicates with any particular point of use, then this will further reduce the quantity of fluid being pumped by the pump to the said point of use.

Each space may communicate successively with a first outlet port, a by-pass port which communicates with the or an inlet port, and a second outlet port. The pump may, moreover, have at least one outlet port which is provided wtih a check valve which ensures that fluid can flow therepast only in the outlet direction and only when the pressure of the fluid exceeds a predetermined value. The by-pass port may overlap predetermined portions only of the first and second outlet ports so that a sealed space may communicate simultaneously with the said by-pass port and with a said portion, the said check valves preventing flow therepast when a sealed space communicates with the said by-pass port.

Preferably, all except not more than two adjacent lobes of each lobed element are partially cut away so that, at any moment, not more than one space is sealed. Preferably, the inner lobed element has the leading face of its leading lobe cut away to prevent fluid from being trapped between the said leading face and a lobe of the outer lobed element. The said leading face is preferably cut away to a position just short of the crown of the respective lobe.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 is a section through a rotary pump according to the present invention,

Figure 2 is a section taken on the line 2—2 of Figure 1,

Figure 3 is constituted by ten sectional views, respectively labelled A to J, each of

which is taken on the line 3—3 of Figure 2, the views A to J respectively showing the parts of the rotary pump in different relative positions, and

Figure 4 illustrates a modification.

In the drawings there is shown a rotary internally meshing gear pump 10 for oil or other liquids having a driving gear element 11 which is mounted within and spaced from an eccentric ring, or cylindrical housing 12. A ring gear element 13 is mounted concentrically within and is rotatable in contact with the eccentric ring 12, the driving gear element 11 being rotatably mounted eccentrically within the ring gear element 13. The ring gear element 13 is provided internally with two adjacent lobes 14 which extend throughout the full axial length of the ring gear element 13, and with a further five lobes 15 which, as shown in Figure 2, are cut away at both their end faces 16, 17, so as to extend in effect for only a minor, and central, portion of the axial length of the ring gear element 13. Thus, the ring gear element 13 has seven lobes 14, 15 of which only the two adjacent lobes 14 extend throughout the full axial length of the ring gear element 13.

The driving gear element 11 is provided externally with two adjacent lobes 20, each of which extends the full axial length of the driving gear element 11, and with four lobes 21 each of which, as shown in Figure 2, is cut-away at the end faces 22, 23, so that only a minor, and central, portion of the lobe is left. Thus, the driving gear element 11 has six lobes 20, 21 of which only the two adjacent lobes 20 extend throughout the full axial length of the driving gear element 11. The ring gear element 13 thus has one more lobe than the driving gear element 11.

The driving gear element 11 is secured to a driving shaft 24 which may, for example, be driven by an electric motor (not shown), the lobes 20, 21 on the driving gear element 11 meshing with the lobes 14, 15 of the ring gear element 13 which is thus rotated within the eccentric ring 12. The lobes 14, 15, 20, 21 define an annular array of six spaces 25 between the elements 11, 13, the volume of the spaces 25 undergoing cyclical alteration of volume in operation.

At one axial end of the eccentric ring 12, there is provided a substantially kidney-shaped inlet port 26. The internal wall of the eccentric ring 12 is provided with outlet grooves 27, 28 which respectively communicate with an outlet port 29 and with an outlet port 30. The curved wall of the ring gear element 13 has a radially extending opening 31 therein which is disposed between the two lobes 14 and which communicates, as shown, with the outlet ports 29 and 30. The outlet port 30 and the opening 31 are brought into and out of communication with each other as the ring gear element 13 is rotated.

The said axial end of the eccentric ring 12 is also provided with a by-pass port 32 which communicates by way of a passage 33 with the inlet port 26, each space 25 in operation communicating successively with the outlet port 29, the by-pass port 32, and the outlet port 30. The outlet ports 29, 30 are respectively provided with check valves 34, 35 which are urged by springs 36, 37 respectively in a closing direction. Thus liquid can flow past the check valves 34, 35 only in the outlet direction and only when its pressure exceeds a predetermined value.

The by-pass port 32 overlaps certain portions of the outlet grooves 27, 28, so that a space 25 may communicate simultaneously with the by-pass port 32 and with a said portion.

The operation of the pump 10 is illustrated in Figure 3 in which the views A to J show the relative positions of the parts as the driving gear element 11 moves through successive angular increments.

When the parts are as shown in Figure 3A, the two full length lobes 20 of the driving gear element 11 are in engagement with the two full length lobes 14 of the ring gear element 13 so as to define a sealed space 25^1 which is completely enclosed except that it communicates with the inlet port 26.

As the driving gear element 11, however, rotates clockwise from the position shown in Figure 3A and through the position shown in Figure 3B, the space 25^1 steadily increases in volume and an increasing volume of liquid is therefore drawn into it. In moving, however, from the position shown in Figure 3B to the position shown in Figure 3C, the space 25^1 when it has reached its maximum volume, ceases to communicate with the inlet port 26 and starts to communicate with the outlet port 29 via the opening 31 and outlet groove 27. As the driving gear element 11 continues to rotate the space 25^1 is gradually reduced in volume, so forcing the liquid out through the outlet port 29.

When, however, as shown in Figure 3D, the space 25^1 communicates with the by-pass port 32, the liquid flows *via* the passage 33 to the inlet port 26. Although at this time the space 25^1 will also communicate successively with the outlet ports 29, 30 by way of the opening 31, the check valves 34, 35 will prevent flow through the outlet ports 29, 30.

Further rotation of the driving gear element 11 will, as shown in Figure 3E, bring the sealed space 25^1 out of the communi-

cation with the by-pass port 32 and, *via* the opening 31 and outlet groove 28, into communication with the outlet port 30 so that the latter receives the final fraction of the liquid being pumped out of the said space 25^1.

There is therefore a cyclical alteration of the volume of the sealed space 25^1 and this cyclical alteration of volume also, of course, occurs in relation to all the other spaces 25 between the lobes of the elements 11, 13. Since, however, the lobes 15, 21 are partially cut-away, these other spaces 25 will not be sealed, and liquid can therefore flow freely out of a reducing space and into a succeeding space.

Once, however, the driving gear element 11 has moved past the position shown in Figure 3E, to the position shown in Figure 3F, all the various spaces 25, between the lobes on the elements 11, 13, are unsealed, as indicated in Figure 3F to Figure 3J. This is because a space 25 will only be sealed when *each* of the lobes 14 simultaneously contacts a lobe 20. Until, however, the driving gear element 11 has turned through six complete revolutions, each of the lobes 14 will not simultaneously contact a lobe 20, and no further pumping therefore occurs until the driving gear element 11 has turned through the said six complete revolutions, after which a further pumping cycle does occur.

Thus during a pumping cycle, only one space 25 is sealed while all the other spaces 25 communicate with each other, whereas during a non-pumping cycle every space 25 is unsealed.

Since each of the spaces 25 is thus periodically sealed and unsealed in operation, and effects a pumping action only when it is sealed, not merely (in the specific embodiment being described) will pumping occur only once in each seven cycles, but even during a pumping cycle only one of the six spaces 25 will effect pumping. The output of the pump is therefore only 1/42 of what it would be if the lobes 15, 21 were not partially cut away, while by reason of the provision of the by-pass port 32 and of the outlet port 30, much of this reduced output does not pass through the outlet port 29. Thus the pump 10 will have an accurately metered small flow while not requiring to be made of very small mechanical components.

In the construction shown in Figures 1 and 2 it may be possible for an additional pumping action to occur in the revolution before the legitimate pumping action takes place. This additional pumping action can arise by reason of the formation of a small closed space between the leading edge of the leading lobe 20 of the driving gear element 11 and the adjacent lobe 15 of the ring gear element 13. The liquid being pumped can enter this small closed space and will then be forced out through the outlet ports 29, 30.

In order to avoid this additional pumping the driving gear element 11 of Figures 1 and 2 may be replaced by a driving gear element 40 as shown in Figure 4. The element 40 is generally similar to the element 11 and will not be described in detail, the element 40 having lobes 41, 42 corresponding to the lobes 20. It will be noted, however, that the leading lobe 42 has its leading face 43 cut away to a position just short of the crown 44 of the lobe 42. As with the other lobes 45 of the element 40, the lobe 42 is so cut away as to leave only a minor central portion thereof, the cut away portions of the lobes 42, 45 being aligned.

Thus liquid cannot become trapped between the leading face 43 and the adjacent lobe 15.

WHAT WE CLAIM IS:—

1. A rotary pump having a housing within which two lobed elements are rotatably mounted one eccentrically within the other, the outer element having one more lobe than the inner element, said lobed elements meshing with each other so that the lobes of each element cooperate with the lobes of the other element during rotation of the elements to define spaces between the elements which successively contract and enlarge as the elements rotate through the point of mesh, and means on at least one said element providing free communication past some but not all of the lobes of the element, so that a sealed space effective to displace fluid from the housing under pressure is defined by the meshing of some but not all of the lobes.

2. A pump as claimed in claim 1 in which predetermined lobes on the lobed elements are partially cut away.

3. A rotary pump as claimed in any preceding claim in which there are a plurality of outlet ports with which each space successively communicates while contracting in volume, whereby each said outlet port receives a proportion only of the volume of the pumped fluid.

4. A rotary pump as claimed in claim 3 in which, in operation, each space communicates successively with a first outlet port, a by-pass port which communicates with the or an inlet port, and a second outlet port.

5. A rotary pump as claimed in any preceding claim in which the pump as at least one outlet port which is provided with a check valve which ensures that fluid can flow therepast only in the outlet direction and only when the pressure of the fluid exceeds a predetermined value.

6. A rotary pump as claimed in claims 4 and 5 in which the by-pass port overlaps predetermined portions only of the first and second outlet ports so that a sealed space may communicate simultaneously with the said by-pass port and with a said portion, the said check valves preventing flow therepast when a sealed space communicates with the said by-pass port.

7. A rotary pump as claimed in any preceding claim in which all except not more than two adjacent lobes of each lobed element are partially cut away so that, at any moment, not more than one space is sealed.

8. A rotary pump as claimed in any preceding claim in which the inner lobed element has the leading face of its leading lobe cut away to prevent fluid from being trapped between the said leading face and a lobe of the outer lobed element.

9. A rotary pump as claimed in claim 8 in which the said leading face is cut away to a position just short of the crown of the respective lobe.

10. A rotary pump substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

J. MILLER & CO.,
Agents for the Applicants,
Chartered Patent Agents,
262 High Holborn,
London, W.C.1.

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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1.

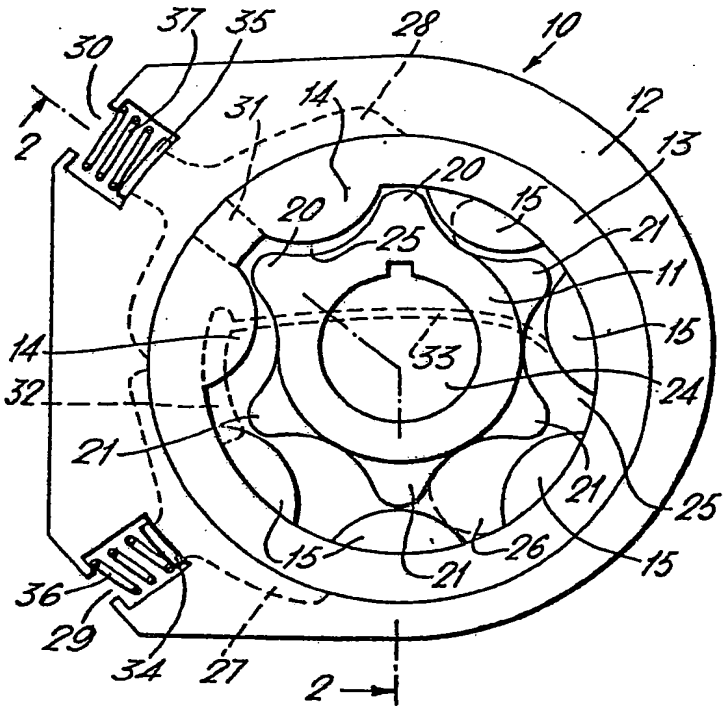


Fig. 2.

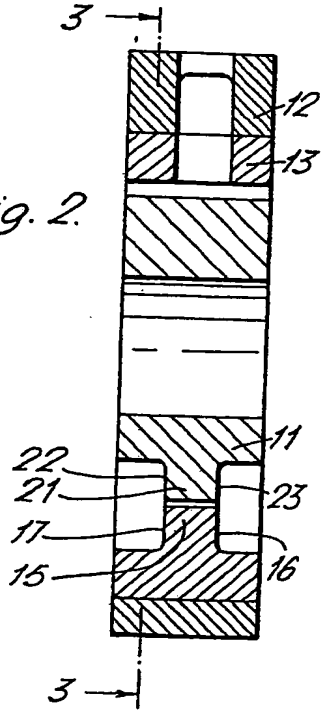
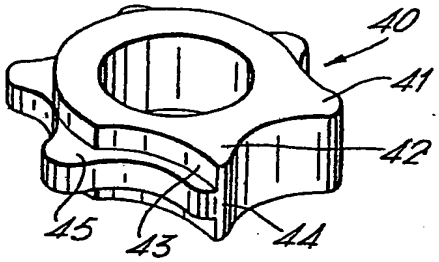


Fig. 4.



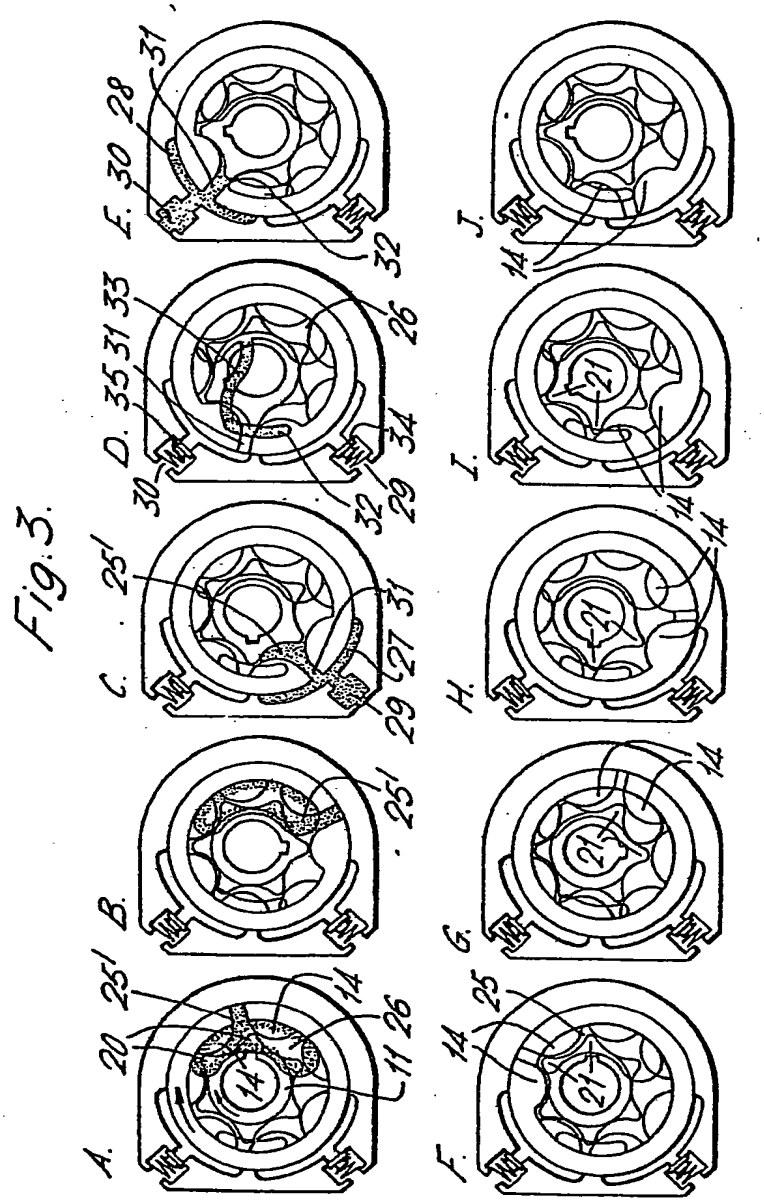


Fig. 3.